

NIST Special Publication 935

***In Situ* Burning of Oil Spills Workshop Proceedings**

New Orleans, Louisiana, November 2-4, 1998

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February 1999



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COVER

U.S. Coast Guard and Minerals Management Service sponsored fire-resistant oil spill containment boom performance test using a non-commercial test boom at the Coast Guard Fire and Safety Test Detachment, Mobile, AL, August 1997. William D. Walton, Photographer.

ISBN No. 1-886843-03-1

National Institute of Standards and Technology Special Publication 935

Natl. Inst. Stand. Technol. Spec. Publ. 935, 114 pages (February 1999)

CODEN: NSPUE2

U.S. GOVERNMENT PRINTING OFFICE

WASHINGTON: 1999

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402-9325

MONITORING OF *IN SITU* BURNING OPERATIONS

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SUMMARY

Monitoring *in situ* burning (ISB) operations requires prompt notification, rapid deployment to the monitoring sites, and prudence in collecting and interpreting the data against background readings and possible interferences. The National Oceanic and Atmospheric Administration (NOAA) and the U.S. Coast Guard (USCG) have developed a monitoring program, recently exercised in two test burns. The exercises provided valuable lessons, and indicated that the monitoring program is feasible.

INTRODUCTION

In situ burning of spilled oil may provide a rapid and efficient method for reducing the environmental damage of oil spills. *In situ* burning, however, emits copious amounts of black smoke. Particulates in the smoke raise concerns of possible impact of the smoke on downwind population centers. As guidelines for incorporating *in situ* burning into regional response plans were being developed around the country, the issue of monitoring *in situ* burning operations became more relevant. In the early 1990s, U.S. Coast Guard District 8 recognized the need to provide the Unified Command with real-time data on ground-level concentration trends of particulates during *in situ* burning operations. Accordingly, NOAA and the U.S. Coast Guard Strike Teams developed the Special Response Operations Monitoring Program (SROMP) to help the Unified Command with decision making during *in situ* burning and dispersant operations[1].

Several land burns and a series of test burns in Mobile, Alabama provided the opportunity to test the SROMP. Based on lessons learned, the SROMP was reviewed, modified, improved, and renamed. The Special Monitoring of Advanced Response Technologies (SMART), a cooperative effort now under way by the Coast Guard, NOAA, U.S. Environmental Protection Agency and the Centers for Disease Control and Prevention will provide a National guidelines for monitoring *in situ* burning and dispersants operations.

MONITORING PROCEDURES

Monitoring *in situ* burning operations presents several challenges:

- Short window of opportunity
- Rapid mobilization and deployment
- Meaningful data collection
- Data interpretation and recommendations

Short Window of Opportunity

In situ burning may have a limited temporal window of opportunity. On land, *in situ* burning may be conducted days, sometimes weeks after the oil has spilled[2], giving all involved enough time to prepare for the burn. On the open seas, *in situ* burning may be limited by dispersion and emulsification of the oil, and by wind and sea conditions. It is advantageous to conduct *in situ* burning as soon after the spill as possible. If monitoring is needed, prompt notification to the monitoring teams may give them enough time to prepare for the burn and deploy on time.

Mobilization and Deployment

Once notified, the monitoring teams should be able to mobilize and reach the monitoring sites quickly, and use whatever transportation is best suited to the task when on site. To achieve this, the teams must have the logistical capabilities to be on call 24 hours a day, and to mobilize and deploy, fully prepared, within a short time (a few hours at most). Under SROMP and SMART, the USCG Strike Teams are tasked with monitoring ISB, and have at their disposal aircrafts, boats, monitoring equipment, and other items needed for successful monitoring. Some states, such as Washington and Hawaii, rely on their own resources to conduct monitoring for *in situ* burning.

SMART recommends using three teams for the monitoring task. The teams constitute a Group under the Incident Command System (ICS), and have their own leader, the Monitoring Group Supervisor. After arriving on site, the Group Supervisor reports to the Operations section in the ICS, get briefed by the Burn Coordinator, and selects monitoring locations. Selection of monitoring location depends on where the smoke is anticipated to go and the presence of population centers. If the smoke trajectory is expected to go over population centers, the monitoring teams are deployed to these locations, choosing specific sites that are as free as possible from interfering factors (e.g., industrial activity) in order to provide objective feedback to the Unified Command. For example, if the teams are deployed to a town (Figure 1), one team deploys upwind in the path of the smoke plume, one deploys downwind, and the third deploys at the discretion of the Burn Coordinator.

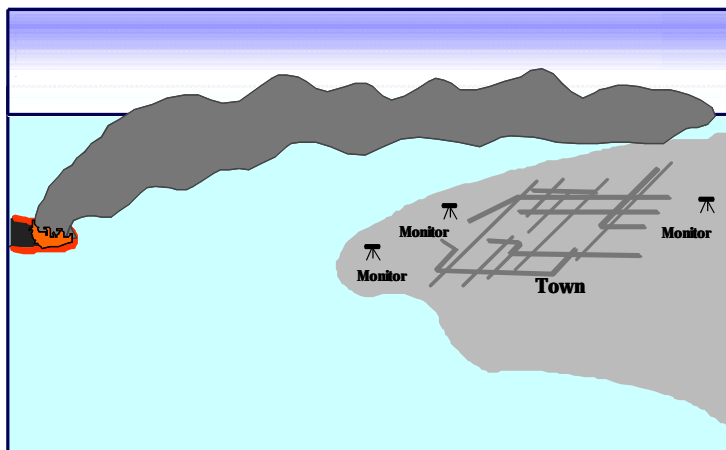


Figure 1. Possible monitoring locations (not to scale)

Data Collection

The monitoring teams are equipped with real-time particulate monitors (DataRam or similar) capable of sampling particulates 10 micrometers or smaller and presenting the data as micrograms per cubic meter of air ($\mu\text{g}/\text{m}^3$). This or similar instruments have been used in the past to monitor numerous burns[3,4]. The instruments provide instantaneous reading of particulate concentrations, as well as a time-weighted average (TWA) over the duration the instrument has been logging data. In addition, each team is equipped with a Global Positioning System (GPS), binoculars, radio, cellular phone, safety equipment, and the necessary recording forms.

Ideally, the monitoring teams are deployed before the burn starts, so that they can record the ambient concentration of particulates. After the burn starts, the teams keep on logging the data, both automatically in the datalogger of the instrument, and manually in a Recorder Log form. The manually-recorded data includes names, instrument number, date, time, location (general and coordinates from GPS), weather on site, and instantaneous and TWA readings every five minutes or less. Comments such as interferences from other factors, smoke direction, and any pertinent detail are recorded as well.

Experience suggests that, if the smoke plume is stable and high overhead, instrument readings will not exceed the ambient levels recorded before the burn. If, however, the plume is low and reaches ground level, such as with high wind conditions, instantaneous readings fluctuate greatly, from ambient concentrations up to momentary readings of several hundred $\mu\text{g}/\text{m}^3$, sometimes higher.

TWA readings are elevated as well, reflecting the trend of higher average particulate levels during that time. The teams pay close attention to the instrument and to the general environment. Higher and erratic instantaneous readings may suggest that particulate concentration from the burn is elevated, but also may suggest interferences from vessels, industry, or other particulate-generating sources. The teams pay special attention to the TWA. Consistently higher TWA readings may indicate an elevated particulate trend. The teams communicate this information to the Group Supervisor, who is on site with the three teams, and the Group Supervisor passes on this information to the Unified Command for consideration.

Data Interpretation and Recommendations

In the Unified Command, the data goes to the Planning section, and specifically to the Technical Advisors. In spills overseen by the USCG, this role is filled by the NOAA Scientific Support Coordinator (SSC). In general, the SSC may use guidance provided by the National Response Team (NRT) to interpret the data and formulate recommendations. The NRT recommends a conservative upper limit of 150 micrograms of PM10 per cubic meter of air, averaged over one hour[5]. Furthermore, the NRT emphasizes that this level of concern does not constitute a fine line between safe and unsafe conditions, but instead should be used as a general guideline. If it is exceeded substantially, human exposure to particulates may be elevated to a degree that justifies terminating the burn. However, if particulate levels remain generally below the recommended limit with few or no transitory excursions above it, there is no reason to believe that the population is being exposed to particulate concentrations above the EPA's National Ambient Air Quality Standard (NAAQS).

When addressing particulate monitoring for *in situ* burning, the NRT emphasizes that concentration trends rather than individual readings should be used to determine whether to continue the burn or to consider terminating it. For SMART operations, the TWA generated by the particulate monitors should be used to ascertain the trend.

The NRT recommends that burning not take place if the air quality in the region already exceeds the NAAQS, and if burning the oil will add to exposure of the general population to particulates. The monitoring teams should report ambient readings to the Unified Command, especially if these readings approach or exceed the NAAQS.

MONITORING THE TEST BURNS IN MOBILE

A series of test burns near Mobile, Alabama, in September of 1997 and 1998 provided an opportunity to exercise the monitoring protocol. The goals of the exercises were to test the procedures of the SROMP and the SMART, and learn from field practice of the monitoring protocol.

The procedure was similar in both years: the monitoring teams assembled at one location, the instruments were set up and calibrated, and any setup problems, were addressed by the group. When ready, the teams deployed in small boats (since the burn was conducted on an island, using boats enabled the teams to monitor far enough downwind) and transited to the burn area. After arriving on location, the teams deployed downwind along the anticipated path of the smoke plume, and started

collecting background readings which varied depending on wind direction and industrial activity; the burn site is near a coal terminal and the ship channel, both of which are sources for particulates. In addition, during calm, stable conditions of early morning, the background concentration of particulates was higher than later in the day.

After the oil was ignited the teams continued logging the data, both in the instruments and manually, recording interferences such as boats passing by and relevant information such as location of the boat relative to the smoke plume, distance from the burn area and locations (based on GPS readings). After the burn ended and the smoke dissipated, the monitoring continued for 15 minutes or so to collect post-burn ambient readings.

To maximize the training opportunity, the boats tried to stay underneath (on some occasions, inside) the smoke plume, so that monitoring personnel could experience recording elevated levels of particulates, comparing instantaneous readings to TWA readings, and communicating data to the Group Supervisor. In a real burn, however, SMART recommends that the teams remain at the location assigned to them, moving only to improve sampling capabilities. Chasing smoke is not the purpose of SMART.

The lessons learned from these burns were quite valuable. The most important lesson is that monitoring *in situ* burning operations by a mobile, flexible team is feasible. First, feedback provided to the Unified Command by on-site, real-time monitoring can enhance decision-making concerning the burn. Second, the instruments proved to be rugged and, in most cases, reliable. Third, manual recording of data may not capture all the momentary excursions of particulate concentration (Figure 2), but adequately follows the time-weighted average, which better conveys particulate concentration trends (Figure 3). Fourth, quality control of the protocol and the data is important, in order to have confidence in the output of the instrument. In addition to the usual steps (e.g., proper calibration, non-use of unfit instrument) it is important to note and record of environmental conditions and interferences that may affect the reading.

CONCLUSIONS

Monitoring *in situ* burning operations present several challenges. The short window of opportunity for *in situ* burning at sea necessitates rapid deployment of the monitoring teams. Once on site, the teams need to collect real-time particulate concentration trends, and convey them to the Unified Command. At the Unified Command the data should be evaluated and, if needed, proper recommendations made regarding the status of the burn. Several exercises and land burns showed that the monitoring protocol is feasible, and the protocol provided valuable lessons learned, among them the importance of quality controls, manual recording of the data, and accounting for possible effects of particulate-generating interfering factors.

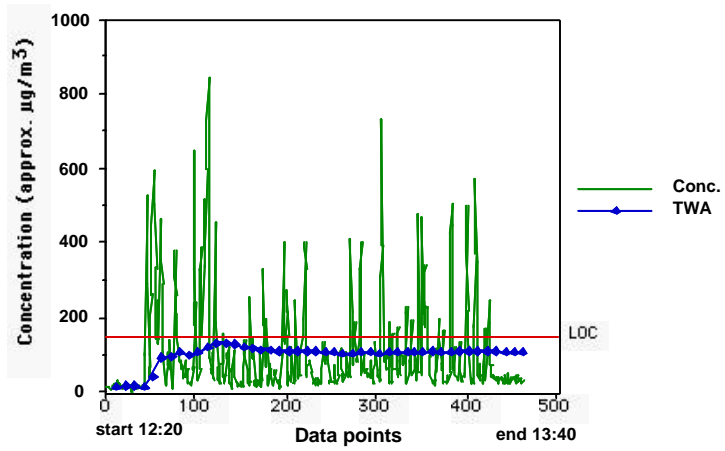


Figure 2. Particulate concentrations from the data logger output.

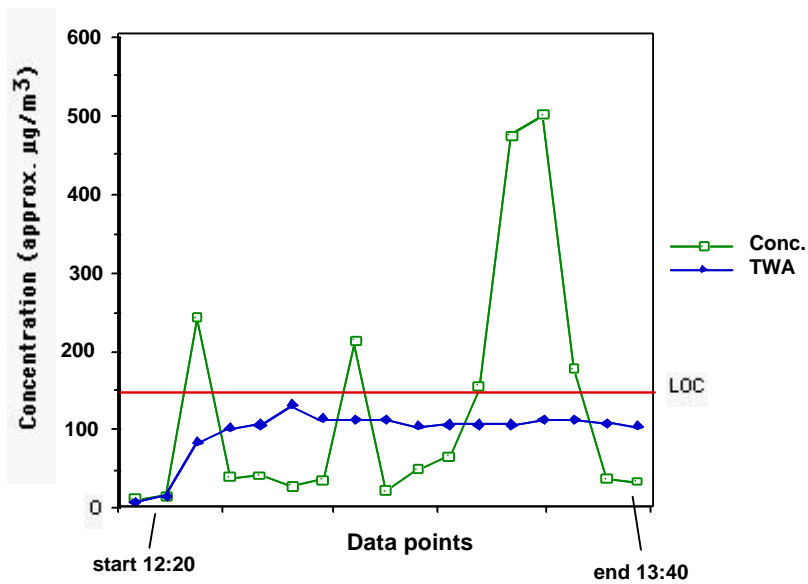


Figure 3. Particulate concentrations based on manually recorded data.

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